CLAIMS

1. A signal processing apparatus operable to represent the effects on a received signal of a radio communications channel having L paths, each path having an average attenuation and a pre-determined respective delay, wherein the received signal includes a combination of correlated components determined from an effect of pulse shaping filters on the received signal, each correlated component having a correlation coefficient representing a correlation of the received signal component with respect to each of the other components, the signal processing apparatus comprising

a plurality of signal simulators, each simulator generating a signal component value proportional to a complex zero mean gaussian random variable having a pre-determined variance, and

a summer operable to sum the signal component values produced from each signal simulator, to form a representation of the signal received via the radio communications channel, wherein the variance of each of the signal simulators is pre-determined by calculating the eigen values of a matrix formed from the correlation coefficients and from a channel correlation matrix which includes the average attenuation of each of the L paths.

2. A signal processing apparatus as claimed in Claim 1, wherein the number of signal simulators is less than the number of paths L of the radio communications channel, the number of signal simulators being determined from the number of eigen values above a pre-determined threshold, each eigen value above the threshold forming the pre-determined variance for a corresponding signal simulator.

3. A signal processing apparatus as claimed in Claim 1, wherein the correlated components from which the received signal is formed are representative of components formed from respective correlators of a rake receiver, the received signal being a spread spectrum signal, the correlation coefficients representing a correlation of the output signal of each correlator with respect to the output of the other correlators.

4. A signal processing apparatus as claimed in Claim 1, wherein the signal component value produced by each signal simulator is formed from a squared magnitude of the zero mean complex gaussian random variable.

5. A signal processing apparatus as claimed in Claim 4, wherein each of the paths L of the multi-path channel i have parameters $(\lambda_i, \tau_i)_{0 \leq i < L}$, where λ_i is the average attenuation of path i having the delay τ_i with respect to a first of the paths, and the summer provides a representation of the received signal r for an input signal s represented by the equation:

$r = s\sum_{i=0}^{L-1}|Y_i|^2$ where $|Y_i|^2$ is the squared magnitude of the complex zero mean gaussian random variable produced by the i-th signal simulator, the gaussian random variable having the pre-determined variance μ_i calculated from the eigen values $(\mu_i)_{0 \leq i < L}$ of the matrix formed matrix $\lfloor(\rho_{ij})_{0 \leq i,j < L}\rfloor \cdot Diag\lfloor(\lambda_i)_{0 \leq i,j < L}\rfloor$, where ρ_{ij} are the L correlation coefficients, and $Diag\lfloor(\lambda_i)_{0 \leq i,j < L}\rfloor$ is the channel correlation matrix for independent paths.

6. A signal processing apparatus as claimed in Claim 5, wherein the correlation coefficients are calculated according to the equation:

$\rho_{ij} = \frac{\sin(\pi\Delta_{ij})\cos(\pi\beta\Delta_{ij})}{\pi\Delta_{ij}(1-4\beta^2\Delta_{ij}^2)}$ where $\Delta_{ij} = \frac{\tau_i - \tau_j}{T_c}$, T_C being the duration of each chip of the received spread spectrum signal and β the roll-off factor.

7. A channel simulator including a signal processing apparatus as claimed in Claim 1, and

a noise generator operable to simulate the effects of noise on the received signal.

8. A channel simulator including a signal processing apparatus as claimed in Claim 7, wherein the noise generator is operable to include the effects of inter symbol interference on the received signal.

9. A channel simulator for representing a radio communications channel in accordance with a markov model, the channel simulator comprising a plurality of channel states representing the states of the radio communications channel, a transition between states being determined according to transition probabilities, wherein the transition probabilities are determined from the effects of the radio communications channel represented by the signal processing apparatus according to Claim 1.

10. A method of representing the effects of a radio communications channel having L paths on a received signal, each path having an average attenuation and a pre-determined respective delay, wherein the received signal includes a combination of correlated components determined from an effect of pulse shaping filters on the received signal, each correlated component having a correlation coefficient representing a correlation of the received signal component with respect to each of the other components, the method comprising

generating a plurality of complex zero mean gaussian random variables each having a pre-determined variance, and

summing the variables, to form a representation of the signal received via the radio communications channel, wherein the pre-determined variance of each variable is calculated from the eigen values of a matrix formed from the correlation coefficients and from a channel correlation matrix which includes the average attenuation of each of the L paths.

11. A method of representing as claimed in Claim 10, wherein the number of complex zero mean gaussian random variables is less than the number of paths L of the radio communications channel, the number of variables being determined from the number of eigen values which are above a pre-determined threshold, each eigen value above the threshold forming the variance for a corresponding one of the gaussian random variables.

12. A method as claimed in Claim 10, comprising

forming a squared magnitude of the zero mean complex gaussian variable, before summing to form the representation of the received signal.

13. A method as claimed in Claim 12, wherein each of the paths L of the multi-path channel i have parameters $(\lambda_i, \tau_i)_{0 \leq i < L}$, where λ_i is the average attenuation of path i having a delay τ_i with respect to a first of the paths, the summing producing the representation of the received signal r for an input signal s according to the equation:

$r = s\sum_{i=0}^{L-1}|Y_i|^2$ where $|Y_i|^2$ is the squared magnitude of the i-th complex zero mean gaussian random variable, the gaussian random variable having the pre-determined variance μ_i calculated from the eigen values $(\mu_i)_{0 \leq i < L}$ of the formed matrix $\lfloor(\rho_{ij})_{0 \leq i,j < M}\rfloor \cdot Diag\lfloor(\lambda_i)_{0 \leq i,j < L}\rfloor$, where ρ_{ij} are the M correlation coefficients, and $Diag\lfloor(\lambda_i)_{0 \leq i,j < L}\rfloor$ is the channel correlation matrix for independent paths.

14. A method of representing as claimed in Claim 13, wherein the correlation coefficients are calculated according to the equation:

$\rho_{ij} = \dfrac{\sin(\pi\Delta_{ij})\cos(\pi\beta\Delta_{ij})}{\pi\Delta_{ij}(1-4\beta^2\Delta_{ij}^2)}$ where $\Delta_{ij} = \dfrac{\tau_i - \tau_j}{T_c}$, T_C being the duration of each chip of the received spread spectrum signal.

15. A method of simulating a radio communications channel, comprising

identifying a number of paths L via which a signal may be received from the radio communications channel,

determining an average attenuation and a pre-determined delay with respect to a first of the paths of a communicated radio signal for each of the paths,

determining a plurality of correlation coefficients from an effect of pulse shaping filters on the received signal,

forming a matrix from the correlation coefficients introduced by the pulse shaping filters and from a channel correlation matrix which includes the average attenuation of each of the L paths,

for each of the paths of the radio channel, calculating a variance of a complex zero mean complex gaussian process from the eigen values of the formed matrix,

generating, for each path, a signal component value proportional to the complex zero mean gaussian random variable having the calculated variance, and

summing the signal component values produced for each path, to form a representation of a signal received via the radio communications channel.

16. A computer program providing computer executable instructions, which when loaded on to a data processor configures the data processor to operate as a signal processing apparatus as claimed in Claim 1.

17. A computer program having computer executable instructions, which when loaded on to a data processor causes the data processor to perform the method according to Claim 10.

18. A data carrier having a recording medium on which is recorded instructions representing the computer program claimed in Claim 16.

19. A computer program providing computer executable instructions, which when loaded on to a data processor configures the data processor to operate as a channel simulator as claimed in Claim 7.